THE INFLUENCE OF SURFACE ROUGHNESS ON ELASTIC NANOINDENTATION MEASUREMENTS

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The characterization of mechanical properties of layered thin-film structures is an important issue with respect to the better understanding and for improving the design of microelectronic devices. Due to the small investigated volume and the easy implementation of the measurement procedure, nanoindentation is an appropriate method for determination of the mechanical properties of thin films systems. Chudoba and Schwarzer et al. [1] developed an analytical approach that allows to derive values of Young´s modulus from load-displacement curves measured within the elastic range of interaction. This analytical approach together with nanoindentation using spherical indenter geometries is employed in this study. Preliminary investigations have been conducted on Fused Silica (FS) standard samples with known values of surface roughness and Young's modulus (E=72 GPa). Different surface roughness values were adjusted by different times of etching the samples with hydrofluoric acid (HF). It could be shown that the roughness has a strong influence on the statistics of the measured load-displacement curves as well as on the derived Young's modulus values (see Figure 1). Therefore, in the current study the influence of surface roughness shall be investigated in a more detailed way. This is done by applying a model that was developed for contact stiffness measurements using AFM-based methods. The model takes into account the contact stiffness of the indenter tip and the investigated sample as well as the contact stiffness of the multiasperity contact, arising from the roughness of the sample and the indenter. The aim of the study is to combine the analysis approach used for AFM data with the nanoindentation measurements and thereby proof the AFM model on a bigger length scale.

[1] N. Schwarzer, T. Chudoba, D. Billep, F. Richter, Surf. Coat. Technol. 116-119 (1999) 244-252

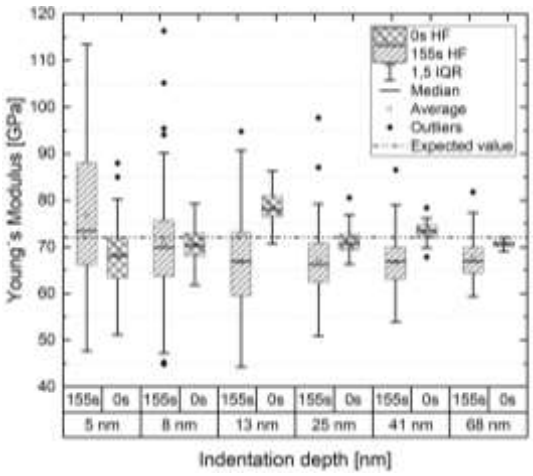

Figure 1 – Preliminary results showing the development of the Young's modulus measurement statistics on Fused Silica after 0s and 155s of HF-etching at different indentation depths. Each box plot represents 56 measurements. With higher surface roughness and lower indentation depths the scatter of the data increases. The Young's modulus values of the rough sample (155s HF) tend to be underestimated.